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ABSTRACT

The concepts "more" and "less" were analyzed into two meaning dimensions, "existence" (derived from children's early language) and "quantity," which were hypothesized to be developmentally related to acts of addition and subtraction. Two experiments tested two- and three-year-olds' comprehension of these concepts when initially equal or unequal rows were added to, subtracted from or left static. Addition and subtraction had little effect on Ss' comprehension of either term. Ss understood "more" first when number characteristics of the array were relatively large, suggesting "many" as an intermediate stage of meaning for "more." No evidence was found for "less" meaning "more," as others have claimed. Ss understood "less" later than "more," a difference attributed to the restricted use of "less" as "smaller in amount." (Author)

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ON THE DEVELOPMENT OF MORE AND LESS

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Abstract

More and less were analyzed into two meaning dimensions, "existence" (derived from children's early language) and "quantity," which were hypothesized to be developmentally related to acts of addition and subtraction. Two experiments tested two- and three-year-olds' comprehension of these concepts when initially equal or unequal rows were added to, subtracted from or left static. Addition and subtraction had little effect on Ss' comprehension of either term. Ss understood more first when number characteristics of the array were relatively large, suggesting 'many' as an intermediate stage of meaning for more. No evidence was found for less meaning more as others have claimed. Ss understood less later than more, a difference attributed to the restricted use of less as 'smaller in amount.'

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ON THE DEVELOPMENT OF MORE AND LESS[1]

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Recent studies of semantic development, which attempt to describe children's acquisition of word meaning as the accumulation of semantic features or components, have primarily explored and derived their evidence from children's knowledge of relationships between words, especially between antonymous pairs of words (e.g., Anglin, 1970; E. Clark, 1971; H. H. Clark, 1970; Donaldson & Wales, 1970). While this paper examines the development of a pair of semantically related words, more and less, it concentrates on how in children's language these words map onto the perceptual world. By analyzing the nonlinguistic contexts in which young children produce and comprehend particular words, it is hoped that the processes by which they acquire words and their meanings can be specified.

An Analysis of the Various Uses and Meanings of More and Less

For adults, more and less encode the relations 'greater in amount' and 'smaller in amount' respectively (hereafter called the "quantity" senses of these terms) and thereby provide a means for quantitatively ordering any two entities. Children's use and comprehension of these terms thus suggest the development of an underlying ability to make simple comparative judgments of quantity. The ability to judge one entity as 'greater than' or 'less than' another seems basic to the kinds of judgments involved in more complex concepts of quantity, such as those based on unit measurement like number, weight, and volume. Investigators in the past have used more and less to

assess the acquisition of such concepts, especially in children four years and older (e.g., Piaget, 1952; Sinclair de Zwart, 1969). In these studies, children are required to comprehend more and less when applied to arrays of objects which are often perceptually misleading. The present experiments used these terms to apply to perceptually simple arrays in an attempt to study two- and three-year-olds' elementary ability to make quantitative judgments.

It has been observed that children younger than two years use more in ways different from the adult use as 'greater than.' On the basis of the nonlinguistic contexts in which her Ss (12 to 23 months) used more, Bloom (1970, in press) inferred that children were expressing the notions (a) 'recurrence' of an object or event (after its intervening disappearance or cessation) and (b) 'another instance of' an already present object; an example of (a): Kathryn (mean length of utterance, MLU 1.32, age 21 months), looking at a picture of cereal after seeing the same picture previously, said "more cereal" (Bloom, 1970); an example of (b): at MLU 1.58, age 22 months, Gia saw two igloos on the page of a book, said, "igloo," pointed to the second one and said "more igloo" (Bloom, unpublished transcript). In both uses of more, children seem to be making underlying judgments about the perceptual and functional similarity of objects and events.

Children's use of more to express 'recurrence' is acceptable in adult English (especially when combined with another quantifier like some or any) and is synonymous with again. Children's use of more as 'another instance of,' is intuitively unacceptable to adults: one cannot describe the second of two objects as "more." However, an examination of Bloom's published and unpublished data by the present investigator indicated that Ss used more in

contexts of both a single other instance and a collection of many other instances. For example, Kathryn (at same MLU and age) said "more toy" as she went to a bag of toys after playing with a wire man (Bloom, 1970). One cannot determine whether Ss distinguish these two uses since at this stage they do not use plural inflections. The sense of more as 'many other similar instances' is like the adult sense of 'additional';[3] for example, the sentence, Here is one rack of dresses, and there are more dresses over there, can be interpreted as being about the presence of other entities similar to an original set without necessarily implying an ordered, 'greater than' relation.

These senses of more, 'again' and 'additional,' describe features of the speech production of children during their second year. Because their psychological distinction is questionable (see Weiner, 1971), these senses are designated here singly as the "existence" sense, "existence" because they convey notions of the presence and similarity of certain objects to other objects. Some investigators have claimed that children can, however, comprehend more in its "quantity" sense at two years, the age at which they seem to be producing the "existence" sense of more.

In a series of experiments designed to test notions of quantity, Mehler and Bever (1967) and Bever, Mehler and Epstein (1968) found that Ss at two years can correctly judge which has "more" after one of two initially equal and aligned rows of objects has been both added to and contracted.[4] The authors argued that Ss comprehended more as a "comparative" term, in the present terminology in its "quantity" sense. Beilin (1968) suggested that Mehler and Bever's Ss responded to E's act of addition as opposed solely to the relative quantity of the rows after the action was completed. In the

distinctions drawn here, Ss might have comprehended more either in its "existence" sense (referring to the similar new objects brought into S's view by E) or its "quantity" sense (the final state of the rows). Ss also could have succeeded simply by choosing the row E changed.

Beilin (1968) and Bever et al. (1968) attempted to test these alternatives. Beilin found that Ss (three to five years) responded to a question with more much better when they could observe an addition or subtraction transformation than when they judged only static unequal rows. Bever et al., however, found that Ss (two to three years) were highly successful in responding to a question with more when shown two static rows. If one examines Mehler and Bever's comparable data from 1967 and 1968, it appears that two-year-old Ss are even more successful in comprehending more when applied to static vs. visibly transformed arrays, a finding contradictory to Beilin's results. It remains unclear, therefore, whether children at two years can comprehend more in its "quantity" sense and, more importantly, what the developmental relationship might be between the "existence" and "quantity" senses.

While there is as yet no evidence, it is at least logically possible that young children could acquire an "existence" sense of less, which is antonymous to that of more, before they acquire less in its "quantity" sense. An utterance less x could be appropriate in a situation where x is present and some or all of x is removed; then less might refer to the removal of x. Thus a (nonarithmetic) 'subtractive' sense of less would be comparable to an 'additional' sense of more (see footnote 3).

Unlike the early frequent use of more, children do not use less when they first begin to talk (see, for example, Bloom, 1970; Braine, 1963; Brown,

in press). Children have other words encoding conditions of removal, disappearance, and nonexistence, namely, no more and all gone, suggesting that the concepts encoded by a hypothetical 'subtractive' sense of less are already available to the young child for less to develop in this way.

Although comprehension of the "quantity" sense of less has been frequently reported for children at about four years (e.g., Beilin, 1965; Sinclair de Zwart, 1969), a strikingly different result has been reported by Donaldson and Balfour (1968). On the basis of a problematic experiment, Donaldson and Balfour inferred that Ss 3-6 (three years, six months) to five years interpret less as if it meant more. This claim, however, is inconsistent with the fact that when Ss of this age first produce less, they do not confuse it with more (see Griffiths, Shantz & Siegel, 1967; Sinclair de Zwart, 1969). Further, this claim becomes ambiguous in light of the distinctions made above: which sense(s) of more does less mean for children? The question remains how the development of less compares with that of more, and if that development can be accounted for in the same hypothetical scheme as that for more.

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The proposed analysis of more and less can be summarized as two hypothetical meaning dimensions with both terms taking contrasting values on each dimension. First, the "existence" dimension, derived primarily from children's early production of more, can be described in terms of contextual features. More can be characterized by the presence of entities similar to an original or particular other entity in one's immediate perceptual surrounds. A possible "existence" sense of less can be characterized by the absence of some entities. Second, on the "quantity" dimension (which need not be described as contextual contrasts, since its use by adults is not context bound), more expresses the

relation of two entities as 'greater in amount' or 'greater extension of quantity,' while less relates two entities as 'smaller in amount' or 'smaller extension of quantity.'

Some Hypotheses on the Development of More and Less and Their Relation to the Development of Quantity

The contexts in which children use more, as well as the findings of Mehler, Bever, and Beilin suggest that acts of addition and subtraction may be critically related to children's developing comprehension of more and less. There are at least three levels to the argument that such a systematic relation exists, and Experiments I and II described below were designed to test these.

First, since children close to two years produce more in situations which can be construed as "addition-like" from the adult vantage point, one might expect Ss to comprehend more in its "existence" sense better in an experimental context in which E brings into view new objects like those present than one in which this cue is not available, as in a subtraction or static contexts. Analogously, if children acquire an "existence" sense of less, its comprehension might depend on the removal of instances[5] which were present. Thus one would expect better comprehension of less in a context in which objects were subtracted than one in which they were either added or left static.

Second, acts of addition and subtraction may be the means by which children develop from the "existence" to the "quantity" senses. Children may eventually realize that the combination of new instances with those present forms a perceptually larger collection than either the original or the new instances alone. The "existence" sense of more might develop into

the "quantity" sense by an understanding of the quantity-changing properties of acts of addition. Analogously, an "existence" sense of less might develop into the "quantity" sense by children's recognition that the removal of objects changes the perceptual dimensions of a collection, and thereby changes its quantitative characteristics.

Experiment II was particularly designed to distinguish "existence" and "quantity" comprehension by separating acts of addition and subtraction from their outcomes relative to a comparison row: half the addition transformations produced more objects relative to the comparison row and half produced less; half the subtraction transformations produced less relative to the comparison row and half produced more. Ss could exhibit "existence" comprehension by choosing the row added to (for more questions) or subtracted from (for less) regardless of what final quantitative relation obtained between the two rows. Further, if addition and subtraction were the means by which children develop "quantity" comprehension of more and less respectively, one might expect in Experiment II a greater number of correct responses to more questions in the addition condition producing relatively more objects than either in the addition condition producing relatively fewer objects or in the static condition. Likewise, one would expect better "quantity" comprehension for less questions in the condition in which subtraction produced relatively fewer objects than in either the static condition or in the condition in which subtraction produced more objects.

The third and broadest level of the argument relating addition and subtraction to children's comprehension of more and less concerns a possible facilitating effect these transformations may have on the development of the general ability to make quantitative comparisons. One could speculate that

acts of addition and subtraction could be "internalized" in Piagetian fashion to become cognitive operations, making any task easier in which Ss judged the relative quantity of objects in contexts where quantity-changing transformations were observed as opposed to in static contexts. While there might be no differential effect of addition on the comprehension of more or subtraction on the comprehension of less, one might expect better performance across both transformation conditions as compared to the static conditions regardless of question asked. Experiments I and II also compare the rates of development of children's comprehension of more and less.

Method

Before each experiment, Ss were asked to point to each section of a two-part board to provide minimal assurance that they understood the parts were to be contrasted. E also asked Ss to name the toys or repeat E's names if S would not do so spontaneously. All Ss and their mothers were middle class, and their first language was English. Ss were seen individually in New York City either in play groups, their homes, or nursery schools. Each experimental session took 10 to 15 minutes.

Experiment IA and IB

Subjects. Ss in IA were 16 boys and girls ranging in age from 2-1 to 3-6 with mean age 2-7. Ss in IB were 18 boys and girls from 3-5 to 3-11 with mean age 3-9.

Apparatus. For both IA and IB toys were arranged in rows on a board which stood at a slight angle from the vertical. The board was 13 inches x 12 inches; the top 6 inches were blue, and the bottom 7 inches were yellow.

Two one-inch shelves 6 inches apart were nailed on horizontally. Toys used on each trial were either identical small blue dolls or red checkers.

Design. There were three transformation conditions: addition (producing more relative to the comparison row), subtraction (producing less relative to the comparison row), and a static inequality. The numbers of toys and the effects of the transformations are shown in Table 1. Ss were asked two

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Insert Table 1 about here

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questions, "Which part has more__?" and "Which part has less__?", making six unique problems: three transformation conditions with two possible questions. In IA, each S received 24 trials, four of each type of problem. Eight Ss were given all more problems on the first day and all less problems on the second day of testing; eight Ss were given the reverse order. Six schedules varied the order of 12 problems. In 1B, Ss were given all 24 problems in a single session. Six schedules varied the 24 problems. All schedules were randomly assigned to Ss.

Procedure. Ss were told that E would place the toys on the board and that they had to tell E about them. For each trial, the toys were arranged on the board out of Ss' view in visual one-to-one correspondence. E continued, "See how many__we've got? Watch me do this to the__." E performed the transformation, then asked the question with more or less. Ss' task was to point to one part of the board in response to E's question.

Experiment IIA and IIB

Subjects. Ss in Experiment IIA were 16 boys and girls from 2-1 to 3-2 with mean age 2-8. Ss in IIB were 36 boys and girls from 3-0 to 4-4 with mean age 3-6.

Apparatus. The board used in Experiment IIA was like that of Experiment I but was 7 inches x 12 inches. The toys used on each trial were either identical small red spacemen or red toy candles. The board and toys for IIB were those used for Experiment I.

Design. There were five transformation conditions: two addition, two subtraction, and one static. One addition transformation produced more objects relative to the comparison row ("addition produces more"); the other addition transformation produced less relative to the comparison row ("addition produces less"). One subtraction transformation produced less relative to the comparison row ("subtraction produces less"); the other subtraction transformation produced more relative to the comparison row ("subtraction produces more"). The numbers of toys and the effects of the transformations are shown in Table 1. For each toy condition, S was asked either "Which part has more__?" or "Which part has less__?", making 10 unique problems: five transformation conditions with two possible questions. Each S received 20 trials, two of each type of problem. Ss in IIA received 10 trials (one of each type) on two separate days. Ss in IIB received all 20 trials in a single session. Ten schedules varied the problems and were randomly assigned to Ss.

Procedure. The procedure was the same as that for Experiment I. Toys were arranged in one-to-one correspondence with the left endpoints of the rows aligned.

Results

The data[6] from Experiments I and II appear in Table 2. Ss' performance in the transformation conditions averaged as compared to the static conditions

for either more or less questions was not different for either experiment or age group (all comparisons were done by a Wilcoxon matched-pairs signed-ranks test unless otherwise noted). Because predictions were made about the specific effects of addition on the comprehension of more and subtraction on the comprehension of less, these data are examined separately.

Insert Table 2 about here

Results for More

It was argued that if children learned the "quantity" sense of more from the "existence" sense by an understanding of acts of addition, they would show better performance when addition produces more than in other conditions. Table 2 shows no difference for more questions between the addition condition and either the static or subtraction condition in Experiment IB. There was also no difference between the addition condition producing more and either the addition condition producing less or the static condition for Experiment IIA or IIB. (Because of an unusual interaction, Experiment IA is discussed separately below.)

It was also suggested that the act of bringing into Ss' view objects like those present might be a critical cue for Ss' "existence" comprehension of more. However, Ss in Experiment IIA and IIB did not choose the row added to significantly more often than the row subtracted from for more questions (in Experiment IIA, 53% choices vs. 62% choices; in IIB, 52% vs. 48% choices).

Ss three to four years (Experiments IB and IIB) were highly successful in interpreting the "quantity" sense of more in each condition. Ss two to three years, however, responded at chance level, .5, in each condition in

Experiment IA (by a t test) and in each condition except one in Experiment IIA, viz., in the subtraction condition producing more ($p < .01$ by χ^2). This large difference between the age groups suggested that Ss intermediate in age (closer to three years) might be more sensitive to the effects of addition on the comprehension of more. Table 3 shows this was not so for Ss in Experiment IIB. Ss in Experiment IIA, however, tended to do better on both the addition condition producing less and the subtraction condition producing more, although in neither case significantly better than the static condition.

Insert Table 3 about here

These trends of Ss around three years, along with the group finding in Experiment IIA that the subtraction condition producing more was the only condition significantly better than chance, suggest that some characteristic of these conditions enabled comprehension of "quantity" more more easily than in other conditions. The addition condition producing less and the subtraction condition producing more differed from the other two transformation conditions only in their initial number difference of five objects; the initial difference in the other two transformation conditions was one object (see Table 1). Further, in the addition condition producing less, one shelf initially had one toy; in the subtraction condition producing more, one shelf had nine toys, taking up the entire space.

Table 3 shows that the percentage correct for more questions in the addition condition producing less for Ss close to three years in Experiment IIA is high compared with the group mean, 56%, indicating that Ss younger than this did considerably worse. Incorrect performance on this condition by Ss

closer to two years means that they are choosing the row added to regardless of its comparative outcome; that is, they seem to be interpreting more questions in an "existence" sense. The data of these seven youngest Ss (ages 2-1 to 2-9) also show a large though not significant difference in the percentage of times they chose the row added to, as opposed to the row subtracted from for more questions (68% vs. 39% choices) suggesting further that the cue of addition might have elicited "existence" comprehension of more.

Experiment IA showed a somewhat different pattern of results for both more and less questions. There appears to be in this experiment a negative effect on Ss' comprehension of the transformation opposite to the one usually associated with a term (see Table 2). For more questions, Ss did worse in the subtraction condition than in either the addition or static condition, although the only significant comparison is between the addition and subtraction conditions with nonchoice responses excluded from the data ($p < .05$). For less questions, Ss did worse on the addition condition than on the subtraction condition ($p < .02$). Further, Ss performed at chance for less questions in the subtraction and static conditions and worse than chance in the addition condition ($p < .02$ by a t test). A possible explanation of this negative effect is presented in the discussion.

Results for Less

It was hypothesized that Ss might develop the "quantity" sense of less first by learning that subtraction decreases quantity. However, Ss' "quantity" comprehension of less questions was no better in subtraction than in static conditions in Experiment IA or IB. Further, in Experiment IIA and IIB,

Ss' "quantity" comprehension of less was not better in the subtraction condition producing less than the subtraction condition producing more or the static condition.

In Experiment IIA and IIB, Ss could have demonstrated a possible "existence" understanding of less apart from "quantity" understanding by choosing the row subtracted from, regardless of its outcome relative to the comparison row. Ss, however, did not show this (in Experiment IIA, 52% choices for the row subtracted from vs. 56% for the row added to; in Experiment IIB, 54% choices vs. 52%).

Ss in Experiment IIA comprehended less questions at chance level in every condition (by χ^2), and better than chance in every condition in IIB ($p < .01$ by χ^2). When the data for Ss about three years were separated from the group data (see Table 3), the pattern of responses for "existence" and "quantity" comprehension was the same as that of the group.

Ss did not understand less to mean more--either in its "existence" or "quantity" senses. If Ss had understood less as an "existence" sense of more based on addition (as McNeill, 1970, suggested), they would have chosen the row added to more often than the row subtracted from, which they did not do (see percentages for Experiment IIA and IIB above). If Ss had understood less as the "quantity" sense of more, they would have chosen the row with more objects, resulting in worse than chance performance for less questions in every condition. The tendency to perform worse than chance for less occurred only in the addition condition in Experiment IA, where a comparable tendency to do worse than chance in the subtraction condition for more also occurred.

In both experiments, however, at least one S responded to less questions by pointing to the row with more objects on N or N - 1 trials. The proportion of such Ss was 1/16 in Experiment Ia, 6/18 in IB, 1/16 in IIa, and 3/36 in IIB. The fact that the proportion was highest in Experiment IB, the oldest group tested, suggests that this tendency may have reflected four-year-old Ss' preference for or perceived salience of longer rows (see Piaget, 1968) rather than their comprehension of less as "quantity" more. In fact, these same Ss were observed during the experiment to tend to point to the longer row before E asked the question with more or less, suggesting that they may have thought this was their task.

There was also a tendency for Ss in Experiments IA and IIA to point to the longer row for less questions when more questions were experienced on the first of the two sessions, while no comparable order effect was found for more. In Experiment IA, when all more questions were given on the first day and all less questions on a second day, Ss chose the longer row for less questions significantly more often than when the opposite order of questions was given (70% choices for day two vs. 66% for day one ($p < .01$ by χ^2). In Experiment IIA, where both more and less questions were given in each session, Ss chose the longer row for less on the first day more often than on the second day (61% choices for day one vs. 41% for day two, $p < .01$ by a Wilcoxon test). Donaldson and Balfour's (1968) claim that Ss interpreted less as more was based on an experiment in which all more questions were given on the first day, and all less questions on a second day. The effects found particularly in Experiment I suggest that their finding might be largely attributable to this order effect.

Experiments IA, IB, IIA, and IIB, together indicate that Ss' overall comprehension of "quantity" more develops earlier than their comprehension of "quantity" less. In each experiment, more was understood better than less, although this difference was significant only for the older Ss ($p < .001$ by t test for both Experiments IB and IIB).

Discussion

While addition and subtraction had some effect on Ss' comprehension, the results showed little consistent facilitating effect that would be expected if these transformations were the critical factors in the development of children's senses of more and less. The results, however, provide new clues about how the "existence" and "quantity" senses of more might be related, about the development of less, its relationship to more, and finally about children's early cognitive ability to make quantitative comparisons.

On the Development of More

The fact that E's question with more occurring after the act of addition was not sufficient to elicit "existence" comprehension cannot be interpreted as evidence for Ss' not having a sense of more of the type described by Bloom (1970, in press). Rather, it only indicates that the experimental context did not elicit it. One possible reason why the experiments failed to do so was provided by informal testing after Experiments IA and IIA. E made two different sized groups of toys, and asked questions such as, "Show me/ Where are there more__?" Ss responded by picking up one toy from a pile or from another source, and saying, "more__," or by peering into the bag of toys, and saying "more__." Thus

the "existence" sense appeared to be in active use by at least some Ss between two and three years. Further, Ss' responses suggest that adequate spatial separation of one instance might be necessary for children's use or comprehension of "existence" more. In the experiments, E always added more than one object so as to form the perceptual unit of a row, and E's question was about the rows. If "existence" more depends on the spatial separation of a single instance, then the experimental procedure did not provide the right cues.

Because Ss' observing an act of addition did not facilitate "quantity" comprehension of more, addition cannot be the developmental link between the "existence" and "quantity" senses. However, Ss in Experiment IIA were sensitive to the number characteristics of the arrays, suggesting an alternative way in which the two senses might be related.

Children may develop an intermediate stage of meaning for more in which this term might mean 'a lot,' 'many,' 'much,' 'being great in extent.' This "intermediate" sense might be like the "existence" sense in that it would apply only to present, similar objects as compared to original objects, but it might differ in that it would apply to collections rather than to single objects. "Intermediate" more would also express an "implicit" quantitative relation ("implicit" in the same sense that an adjective, like tall, has an "implicit" relation to some standard or average) but might differ from the "quantity" sense in that the former would not apply to all quantitative relations of 'greater in amount'; its range of application might be limited, for example, by some perceptually optimal range of quantitative (number) differences between sets of objects. Thus a tentative sequence for the development of more (and by implication for the development of quantity as

McNeill) might be: (a) "existence," applying to single objects, (b) "intermediate," applying to collections within some perceptually defined range, and (c) "quantity," the universally applicable relation.

On the Development of Less

The clearest result about less is that children comprehend it later than more, a fact which suggests that its pattern of acquisition is different from that of more. Some discussions of these terms (e.g., H. H. Clark, 1970; Huttenlocher & Higgins, 1971; McNeill, 1970) have proposed analyses of the linguistic relations between them to account for findings related to this one. These discussions point out that less is linguistically more complex than more, and therefore the psychological processes involved in its use and comprehension are presumed to be more complex than those for more.

The accounts of the relative linguistic and psychological complexity of less do not provide adequate explanations of how it develops, since they lead to predictions which are not supported by the present data. First, H. H. Clark (1970) and McNeill (1970) specifically argued that because marked adjectives in an antonymous pair "derive" their meaning from their unmarked counterparts, one might expect, as Donaldson and Balfour found, that children would confuse less (the marked) with more (the unmarked). The present data, however, show that children do not confuse less either with a sense of more based on the addition of objects or with the sense of more as 'greater in amount.' There is also no evidence for Clark's proposal that less may first mean 'some.' Second, Huttenlocher and Higgins (1971) suggested that more and less used as adverbs in comparative adjectival constructions designate "addition" and "subtraction" respectively. Notions

of resulting 'presence,' they continued, are psychologically easier than notions of 'absence.' Subtraction and addition did not differ in difficulty in the present experiments; thus the developmental difference between more and less cannot be explained by reference to the greater difficulty of subtraction. This need not imply that more and less for children or adults do not involve notions of 'presence' or 'absence' respectively without associated "mental acts" of addition and subtraction, or that 'absence' is not somehow a more difficult notion than 'presence.'

While children's first uses of more encode a variety of simple, sensory-motor notions which are also expressed by adults, the evidence thus far indicates that for adults and children less encodes only the quantitative relation 'smaller in amount,' a more sophisticated notion than that expressed by the "existence" sense of more. Indeed if less encodes only a quantitative relation, while more encodes cognitively simpler notions as well, one would expect children not only to use and understand less later than more, but to do so at a time when they can express other elementary quantitative relations. Because of its restricted application, adults may use less relatively infrequently, a possibility in itself causing less to be acquired later than more.

The evidence indicates that the "quantity" sense of more has some dominant function in the development of the ability to make quantitative comparisons. The fact that Ss (especially those close to four years) showed some preference for the longer row is reminiscent of Piaget's (1952, 1968) observation that Ss of four years choose the longer row in number conservation tasks, even though it may have fewer objects. The importance of this psychological fact about the perception of quantity and the comprehension of more suggests that children's acquisition of less may depend on their

understanding of how "quantity" more applies to objects. The data indicate that Ss who understood "quantity" more did not yet know its logically converse property, that the other set is necessarily 'smaller in amount' than the set judged 'greater in amount' (an observation also made by Beilin, 1964, and Donaldson and Balfour, 1968). Less may first be learned as applying to that "other" or "second" set of objects to which the "quantity" sense of more does not apply; it may first be acquired as the "perceptual converse" of "quantity" more.

The Results of Experiment I

Because Experiment I showed a negative effect of the transformations on Ss' comprehension not evident in the other experiments, Ss must have had some "association" between addition with more and subtraction with less to have responded systematically when either term was paired with the opposite transformation. Contrasting Ss' task in the two experiments provides clues to the reasons for this effect.

The transformation conditions of Experiment I presented Ss first with two equal rows in one-to-one correspondence. Any transformation of one row has particular salience because it destroys the symmetry of the array. The initial symmetry might have caused Ss to treat the row which E did not change as a "mnemonic" or indicator of the initial state, against which the altered row could be contrasted. The transformed row in such an array was always the "different" one (either shorter or longer) as compared to the original arrangement. Given that Ss had a strong enough association of a term with its respective transformation to cause confusion when the pairings were crossed, Ss might have adopted a "best guess" strategy: when in doubt, choose the "different" row.

Experiment II did not provide young Ss with the opportunity for manifesting such a "best guess" strategy. In Experiment I, two-thirds of the trials began with an initially equal and symmetric array. In Experiment II, initially unequal, asymmetric rows were presented on every trial; each trial also began with a different number combination. Because the rows were asymmetric in both the initial and final states in Experiment II, there was no perceptual "mnemonic" to aid Ss in remembering which row was transformed. Without a "different" row to choose, Ss' hypothesized confusion between term and transformation might result in random choices, as was found in Experiment IIA.

The Development of the Cognitive Ability to Make Quantitative Comparisons

The argument that both addition and subtraction transformations might aid the acquisition of the general cognitive ability to make quantitative comparisons received no support from the data. It must be noted that this result is discrepant with Beilin's (1968) finding. There is in fact no substantive evidence in the experiments that Ss understood the quantity-changing properties of addition and subtraction, although the data show effects of the initial state of the rows (Experiment II), the transformations (Experiment I), and the final state (both experiments).

Other evidence suggests that Ss just learning to make quantitative comparisons can do so under static conditions. On a third day of testing, 10 Ss randomly chosen from Experiment IA and 14 Ss from Experiment IIA who did not get 75% of all problems correct were presented with only static unequal rows of toys for 12 trials. Ss' task was to choose one row for themselves or for E (the assumption was that Ss would want to keep more and give away less). Ss

were more successful in this task than they were overall in Experiments IA and IIA, which included transformations (for Ss from Experiment IA, 43% correct vs. 64%, $p < .01$; for Ss from Experiment IIA, 52% correct vs. 66%, $p < .05$). These differences also lend support to Piaget's (1967) hypothesis that the development of cognitive structures precedes the development of associated linguistic structures.

It appears, however, that children at first may be able to make such "nonlinguistic" quantitative judgments in one direction only. The percentage correct in the "keep" and "away" task is not different from the percentage correct for more questions alone for Ss in Experiment IIA (66% vs. 64%). Because "keep" and "away" instructions do not specify the direction of the comparison as more and less do, Ss could have succeeded on the basis of the same underlying cognitive ability allowing the comprehension of the "quantity" sense of more. Ss could have merely decided which row had the greater quantity and have given E the other row without ever judging that E's row was smaller in amount. If this is so, the development of the linguistic ability to understand "quantity" more, and the relative difficulty of understanding less, could be considered a direct result of the cognitive, nonlinguistic factors enabling the development of simple quantitative, relational judgments. The continued exploration of the kinds of judgments involved in children's use and interpretation of words will perhaps prove most productive in describing and explaining their development.

References

Achenbach, T. M. Conservation below age three: Fact or artifact? In Proceedings, 77th Annual Convention, American Psychological Association, 1969, 275-276.

Anglin, J. M. Growth of word meaning. Cambridge, Mass.: MIT Press, 1970.

Beilin, H. Perceptual-cognitive conflict in the development of an invariant area concept. Journal of Experimental Child Psychology, 1964, 1, 208-226.

Beilin, H. Learning and operational convergence in logical thought development. Journal of Experimental Child Psychology, 1965, 2, 317-339.

Beilin, H. Cognitive capacities of young children: A replication. Science, 1968, 162, 920-921.

Bever, T. G., Mehler, J., & Epstein, J. What children do in spite of what they know. Science, 1968, 162, 921-924.

Bloom, L. M. Form and function in emerging grammars. Cambridge, Mass.: MIT Press, 1970.

Bloom, L. M. One word at a time: The use of single word utterances before syntax. The Hague: Mouton, in press.

Braine, M. D. S. The ontogeny of English phrase structure: The first phase. Language, 1963, 39, 1-13.

Brown, R. A first language. Cambridge, Mass.: Harvard University Press, in press.

Calhoun, L. G. Number conservation in very young children: The effect of age and mode of responding. Child Development, 1971, 42, 561-572.

Clark, E. On the acquisition of the meaning of before and after. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 266-275.

Clark, H. H. The primitive nature of children's relational concepts. In J. R. Hayes (Ed.), Cognition and the development of language. New York: Wiley, 1970.

Donaldson, M., & Balfour, G. Less is more. British Journal of Psychology, 1968, 59, 461-471.

Donaldson, M., & Wales, R. On the acquisition of some relational terms. In J. R. Hayes (Ed.), Cognition and the development of language. New York: Wiley, 1970.

Griffiths, J. A., Shantz, C. A., & Siegel, I. E. A methodological problem in conservation studies: The use of relational terms. Child Development, 1967, 38, 841-848.

Hayes, J. The effect of proximity, length and number. Edinburgh, Scotland: University of Edinburgh, July 1969. (Mimeographed)

Huttenlocher, J., & Higgins, E. T. Adjectives, comparatives, and syllogisms. Psychological Review, 1971, 78, 487-504.

Kennedy, G. D. Comprehension of English sentences comparing quantities of discrete objects. Unpublished doctoral dissertation, University of California, Los Angeles, 1970.

McNeill, D. The acquisition of language. New York: Harper and Row, 1970.

Mehler, J., & Bever, T. G. Cognitive capacities of very young children. Science, 1967, 158, 141-142.

Piaget, J. The child's conception of number. New York: Humanities Press, 1952.

Piaget, J. Language and thought from a genetic point of view. In D. Elkind (Ed.), Six psychological studies. New York: Random House, 1967.

Piaget, J. Quantification, conservation, and nativism. Science, 1968, 162, 976-979.

Rothenberg, B. B., & Courtney, R. G. Conservation of number in very young children: A replication of and comparison with Mehler and Bever's study. Journal of Psychology, 1968, 70, 205-212.

Sinclair de Zwart, H. Developmental psycholinguistics. In D. Elkind and J. H. Flavell (Eds.), Studies in cognitive development: Essays in honor of Jean Piaget. New York: Oxford University Press, 1969.

Weiner, S. L. On the development of more and less. Unpublished doctoral dissertation, Columbia University, New York, 1971.

Footnotes

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[2]Now at Educational Testing Service.

[3]Additional is used here technically in the sense of 'extra,' 'other' or 'further.' It is to be distinguished from the 'arithmetic' sense of additional which conveys a quantitative comparison. 'Arithmetic' additional applies specifically when a second quantity, the addend, is combined with an original quantity, the augend, to form a sum necessarily greater in amount than either. The "additional" amount then serves to produce a quantity greater than the original or itself, thus implying a quantitatively ordered relation.

[4]Mehler and Bever's (1967) experiments resulted in several replication attempts, some of which succeeded at least partially (Calhoun, 1971; Rothenberg & Courtney, 1968) and some of which failed (Achenbach, 1969; Hayes, 1969).

[5]Although in adult American English it is usually unacceptable to use less for discrete quantities, the present use of less in this way is based on the assumptions that children learn less before the acceptable term fewer, and that use and comprehension of fewer develops out of the more general notion of less. Other American studies using less with children in this way have had no resulting problem (e.g., Beilin, 1965; Griffiths, Shantz, & Siegel, 1967; Kennedy, 1970).

[6] Ss did not always respond by choosing one part of the board. Such "nonchoice" responses (e.g., pointing to both parts, talking about something else) can be counted as errors or can be excluded from the data calculations, and thereby inflate the percent correct. All tests and comparisons are reported for nonchoice responses counted as errors. The results also hold when nonchoice responses are excluded unless otherwise cited.

Table 1

Conditions in Experiments I and II

Transformation Type	Numbers of Toys	
	Experiment I	Experiment II
Addition Produces More	4 4 4 + 2 = 6	4 4 3 + 3 = 6
Addition Produces Less		6 6 1 + 3 = 4
Subtraction Produces Less	4 4 4 - 2 = 2	6 6 7 - 3 = 4
Subtraction Produces More		4 4 9 - 3 = 6
Static	6 4	6 4

Table 2

Percentage of Correct Responses for Experiments I and II

Transformation[a] Condition	Experiments I	Ia	II	IIa
More Question				
+ Produces More	52 (57)	99 (99)	62 (62)	86 (86)
+ Produces Less			56 (56)	83 (84)
- Produces Less	33 (36)	96 (96)	59 (59)	86 (87)
- Produces More			84 (84)	82 (83)
Static	47 (57)	94 (94)	56 (58)	83 (84)
Less Question				
+ Produces More	31 (33)	47 (47)	47 (48)	61 (61)
+ Produces Less			59 (59)	65 (65)
- Produces Less	55 (61)	53 (53)	50 (50)	71 (72)
- Produces More			47 (47)	64 (65)
Static	41 (46)	49 (49)	44 (45)	69 (70)

Note--Numbers in parentheses are calculated with nonchoice responses excluded from the data.

[a]"+" means "addition"; "-" means "subtraction."

Table 3

Percentage of Correct Responses for Ss Closest to Three Years in Experiments IIA and IIB

Transformation Condition	Experiments	
	IIA[a]	IIB[b]
More Question		
+ Produces More	61	85
+ Produces Less	78	85
- Produces Less	61	85
- Produces More	87	95
Static	61	80
Less Question		
+ Produces More	44	40
+ Produces Less	61	50
- Produces Less	50	60
- Produces More	56	55
Static	50	65

Note--Proportions in this table were not affected when nonchoice responses were excluded from the calculations.

[a] N = 9; ages ranged from 2-10 to 3-2 with mean age 2-11.

[b] N = 10; ages ranged from 3-0 to 3-3 with mean age 3-2.